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PATENT SPECIFICATION



627,004

Application Date : April 22, 1944.

No. 7825/44.

Complete Specification Left : Jan. 19, 1945.

Complete Specification Accepted : July 26, 1949.

Index at acceptance:—Class 78(iii), C(4: 19).

PROVISIONAL SPECIFICATION.

Improvements in Electric Jack-type Actuators.

We, MILES AIRCRAFT LIMITED, a British Company, of The Aerodrome, Reading, Berks., extension being fitted with a ball or other type

PATENTS ACT, 1949

SPECIFICATION NO. 627,004

Reference has been directed, in pursuance of Section 8 of the Patents Act, 1949, to Specification No. 587,742.

THE PATENT OFFICE,
18th November, 1950.

DS 58026/ 3(3)/3464 150 11/50 R

The chief object is to evolve an electric jack-type actuator of compact and simple construction involving the minimum number of component parts which can be easily assembled together.

An electric jack-type actuator in accordance with the invention comprises a casing, an electric motor located within said casing, an epicyclic-type gear co-axially arranged with respect to the driving shaft of said motor and also located within said casing, a ram slidable within bearings formed in an extension of said casing, and a worm in screw-threaded engagement with said ram and in driving connection with said epicyclic gear so as to rotate at a proportionately low speed relative to the rotational speed of the electric motor to cause axial movement of said ram within the casing extension.

In a preferred embodiment of the invention, the actuator includes a cylindrical casing which is divided diametrically into two compartments, the casing being composed of non-magnetic material and containing a permanent magnet-type electric motor. The second compartment contains an epicyclic-type gear which will provide the desired reduction ratio, the epicyclic-type gear being in driving connection with the motor shaft. The casing is closed at its opposite ends by separately-formed end caps, the end cap adjacent the epicyclic gear being formed with a tubular part constituting an extension of the casing, the extension being bored for the reception of a ram slidable mounted therein, the

ment member for connection with the part which is to be moved. The end cap provided on the opposite end of the casing is likewise adapted for attachment with a fixed part of the structure.

The epicyclic gear employed preferably includes an internally-toothed annulus which is located in position within the casing and is locked against rotational movement by securing screws which also serve to maintain the adjacent end cap in position, the epicyclic gear also including a plurality of gear carriers, one of which is attached to the worm, the carrier at the opposite end being adapted for connection with the driving shaft of the electric motor. Each carrier is fitted with a number of planet gears which mesh with the internally-toothed annulus, and in this connection it will be appreciated that the desired gear ratio can be obtained to suit any particular purpose for which the actuator is intended by increasing or decreasing the number of carriers employed, each carrier and its associated planet wheel consisting of a self-contained unit, with the exception of the endmost carrier, which is rigidly attached to the worm.

It will be appreciated from the foregoing description that the actuator hereinbefore described is of simple construction and includes the minimum number of operating parts, the electric motor and components of the epicyclic gear being assembled together within the casing prior to the application of the end cap, the end cap being finally placed in position on the casing

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PROVISIONAL SPECIFICATION. Improvements in Electric Jack-type Actuators.

We, MILES AIRCRAFT LIMITED, a British Company, of The Aerodrome, Reading, Berkshire, and ARTHUR STEWART HAWKINS, a British Subject, of the Company's address, do hereby declare the nature of this invention to be as follows:—

This invention relates to electric jack-type actuators of the kind including a worm-actuated ram, the worm being driven by an electric motor through the medium of reduction gearing, such actuators being intended primarily for use on aircraft for the operation of cooling gills, bomb doors, or other component parts which require to be adjusted or otherwise moved from time to time.

The chief object is to evolve an electric jack-type actuator of compact and simple construction involving the minimum number of component parts which can be easily assembled together.

An electric jack-type actuator in accordance with the invention comprises a casing, an electric motor located within said casing, an epicyclic-type gear co-axially arranged with respect to the driving shaft of said motor and also located within said casing, a ram slidable within bearings formed in an extension of said casing, and a worm in screw-threaded engagement with said ram and in driving connection with said epicyclic gear so as to rotate at a proportionately low speed relative to the rotational speed of the electric motor to cause axial movement of said ram within the casing extension.

In a preferred embodiment of the invention, the actuator includes a cylindrical casing which is divided diametrically into two compartments, the casing being composed of non-magnetic material and containing a permanent magnet-type electric motor. The second compartment contains an epicyclic-type gear which will provide the desired reduction ratio, the epicyclic-type gear being in driving connection with the motor shaft. The casing is closed at its opposite ends by separately-formed end caps, the end cap adjacent the epicyclic gear being formed with a tubular part constituting an extension of the casing, the extension being bored for the reception of a ram slidably mounted therein, the

extension being fitted with a ball or other type bearing in which is mounted a driving worm in screw-threaded engagement with internally-arranged screwthreads in the interior of the ram, the arrangement being such that rotational movement of the worm by way of the epicyclic gear and motor will result in axial movement of the ram within the extension.

The extension at its end is fitted with a bearing in which the ram is slidable, the bearing having a keyed or other connection with the ram to prevent the latter rotating about its axis under the action of the worm, the ram at its extremity being fitted with a bifurcated attachment member for connection with the part which is to be moved. The end cap provided on the opposite end of the casing is likewise adapted for attachment with a fixed part of the structure.

The epicyclic gear employed preferably includes an internally-toothed annulus which is located in position within the casing and is locked against rotational movement by securing screws which also serve to maintain the adjacent end cap in position, the epicyclic gear also including a plurality of gear carriers, one of which is attached to the worm, the carrier at the opposite end being adapted for connection with the driving shaft of the electric motor. Each carrier is fitted with a number of planet gears which mesh with the internally-toothed annulus, and in this connection it will be appreciated that the desired gear ratio can be obtained to suit any particular purpose for which the actuator is intended by increasing or decreasing the number of carriers employed, each carrier and its associated planet wheel consisting of a self-contained unit, with the exception of the endmost carrier, which is rigidly attached to the worm.

It will be appreciated from the foregoing description that the actuator hereinbefore described is of simple construction and includes the minimum number of operating parts, the electric motor and components of the epicyclic gear being assembled together within the casing prior to the application of the end cap, the end cap being finally placed in position on the casing

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and the ram inserted within the extension; the bearing for the ram located within the extension being finally placed in position to prevent rotational movement of the ram taking place during operation.

The actuator is of compact construction and light in weight, and is suitable particularly for use on aircraft for the operation of cooling gills, bomb doors, or other component parts which require adjustment or operation from time to time with the expenditure of the minimum

amount of electric current, it being intended that the various actuators used on an aircraft shall be all operated from the storage batteries normally carried.

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Dated this 26th day of April, 1944.

For the Applicants:

F. J. CLEVELAND & COMPANY,
Chartered Patent Agents,
29, Southampton Buildings, Chancery Lane,
London, W.C.2.

COMPLETE SPECIFICATION.

Improvements in Electric Jack-type Actuators.

We, MILES AIRCRAFT LIMITED, a British Company, of The Aerodrome, Reading, Berkshire, and ARTHUR STEWART HAWKINS, a British Subject, of the Company's address, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to electric jack-type actuators of the kind including a screw jack or ram, driven by an electric motor through the medium of reduction gearing, such actuators being intended primarily for use on aircraft for the operation of cooling gills, bomb doors, or other component parts which require to be adjusted or otherwise moved from time to time.

The chief object is to evolve an electric jack-type actuator of compact and simple construction involving the minimum number of component parts which can be easily assembled together.

The invention provides an electric jack type actuator, comprising an electric motor, a screw jack, and reduction gearing disposed between the motor and the screw mechanism of the jack for driving said mechanism from the motor, wherein said motor, gearing, and screw jack are co-axially disposed in the order mentioned in the lengthwise direction of the actuator. This combination, and the specified disposition of the component parts thereof, makes for a compact construction of actuator having a comparatively small girth and void of all excrescences. The actuator is therefore well adapted for use in aircraft wherein these features are of prime importance. Furthermore, the actuator is capable of exerting a wholly-axial thrust or pull.

The invention further provides an electric jack type actuator constituting a unit of elongated cylindrical form and comprising an elongated casing, an electric motor mounted at one end thereof and having an output shaft disposed lengthwise of the casing, reduction gearing in the casing and driven from the shaft, a screw jack disposed axially of the casing at the other end thereof which jack includes relatively rotatable and extensible male and female members whereof one is driven by the gearing to screw the other lengthwise thereof, means at said other end of the casing for guiding the said

other jack member for linear movement axially of the casing, and means for restraining said other jack member from rotation in relation to the casing.

The reduction gearing is advantageously epicyclic gearing, for thereby the substantial speed reduction which in general will be necessary may be achieved without undue bulk. According to an important subsidiary feature of the invention, the epicyclic gearing consists of a plurality of individual readily-replaceable units, each comprising a gear carrier mounting a number of planet gears and a centrally-arranged sun wheel, the planet gears when the units are assembled together serving to transmit the drive from a pinion on the motor shaft to a final carrier secured to a worm shaft, the final carrier mounting planet gears which are adapted to mesh with the sun wheel on the next adjacent carrier, the planet gears of all the carriers meshing with an internally-toothed fixed annulus in the casing.

It is preferred to provide the aforesaid one jack member with a bearing which is disposed at an end of said member adjacent the gearing. The bearing may serve the double function of a thrust-and-journal bearing.

The electric motor is preferably of the permanent magnet type, and the invention also includes an electric jack-type actuator comprising a two-compartment casing; a permanent magnet electric motor located within one compartment and in driving connection with epicyclic type reduction gearing located within the other compartment, an extension on said casing, beyond said other compartment, and an axially-movable ram slidable within said extension, and a worm disposed co-axially of the motor in threaded engagement with corresponding threads in said ram and in driving connection with said epicyclic gearing, and means for preventing rotational movement of said ram within its associated extension.

In order that the invention may be clearly understood and readily carried into effect, a preferred embodiment of it is hereinafter described with reference to the accompanying drawing, wherein:

Fig. 1 is a longitudinal section of an electric jack-type actuator constructed in accordance

with the invention;

Fig. 2 is a cross-section on the line II-II of Fig. 1 drawn to an enlarged scale;

Fig. 3 is a cross-section on the line III-III of Fig. 1, also drawn to an enlarged scale; and

Fig. 4 is an exploded sectional view showing the manner in which the epicyclic type gear units are assembled together.

In the construction illustrated the actuator includes a cylindrical casing 1 which is divided diametrically into two compartments 2 and 3, the casing being composed of non-magnetic material, the compartment 2 containing a reversible permanent magnet type electric motor 4. The second compartment 3 contains an epicyclic type gear which will provide the desired reduction ratio, the epicyclic type gear being in driving connection with the motor shaft. The casing is closed at its opposite ends by separately-formed end caps 5 and 6, the end cap 6 adjacent the epicyclic gear being formed with a tubular part 7 constituting an extension of the casing. The casing-extension is bored for the reception of a ram 8 slidably mounted therein and is fitted with a ball or other type thrust-and-journal bearing 9 in which is mounted a driving worm 10 in screwthreaded engagement with the internally-arranged screwthreads 11 in the interior of the ram 8, the arrangement being such that rotational movement of the worm by way of the epicyclic gear and motor will result in axial movement of the ram within the extension. It will be noticed that the dual-purpose bearing 9 is fitted at that end of the worm 10 which is adjacent to the gearing, and the motor 4, the gearing, and the screw jack (comprising ram 8 and worm 10) are co-axially disposed in the order mentioned in the lengthwise direction of the actuator.

The extension 7 at its end is fitted with a bearing 12 in which the ram is slidable, there being a keyed connection 13 with the ram to prevent the latter rotating about its axis under the action of the worm, the ram at its extremity being fitted with a bifurcated attachment member 14 for connection with the part which is to be moved. The end cap provided on the opposite end of the casing is likewise formed with a bifurcated part 15 adapted for attachment with a fixed part of the structure.

The epicyclic gear employed preferably includes an internally-toothed annulus 16 which is located in position within the casing and is locked against rotational movement by securing-screws 17 (one of which is shown) which also serve to maintain the adjacent end cap 6 in position, the epicyclic gear also including a plurality of gear carriers 18, one of which is attached to the worm, the carrier at the opposite end being adapted for connection with the driving shaft of the electric motor. Each carrier is fitted with a number of planet gears 19 which mesh with the internally-toothed annulus 16; and in this connection it will be appreciated that the desired gear ratio can be obtained to

suit any particular purpose for which the actuator is intended by increasing or decreasing the number of carriers employed, each carrier and its associated planet wheels consisting of a self-contained unit, with the exception of the endmost carrier, which is rigidly attached to the worm.

The arrangement of the gear carrier units is shown more clearly in Fig. 4, this figure showing the manner in which a gear of any desired reduction ratio can be built by assembling together the appropriate number of units and utilising a fixed annulus of appropriate length. The gear carrier unit which is remote from the worm 10 has its planet gears in driving connection with a pinion 20 on the motor shaft. Each carrier with the exception of the one associated with the driving worm 10 mounts a centrally-arranged sun wheel 21 which meshes with the planet gears of the adjacent carrier, the sun wheels 21 and their associated carriers being locked against relative rotational movement.

The bearing 9 is maintained in position by means of a plate 22, which in turn is secured in position by screws 23, one only of which is shown.

It will be appreciated from the foregoing description that the actuator hereinbefore described is of simple construction and includes the minimum of operating parts, the electric motor and components of the epicyclic gear being assembled together within the casing prior to the application of the end cap, the end cap being finally placed in position on the casing and the ram inserted within the extension; the bearing for the ram located within the extension being finally placed in position to prevent rotational movement of the ram taking place during operation.

The actuator is of compact construction and light in weight, and is suitable particularly for use on aircraft for the operation of cooling gills, bomb doors, or other component parts which require adjustment or operation from time to time with the expenditure of the minimum amount of electric current, it being intended that the various actuators used on an aircraft shall be all operated from the storage batteries normally carried.

The actuator may be fitted if desired with a limit switch.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An electric jack type actuator, comprising an electric motor, a screw jack, and reduction gearing disposed between the motor and the screw mechanism of the jack for driving said mechanism from the motor, wherein said motor, gearing, and screw jack are co-axially disposed in the order mentioned in the lengthwise direction of the actuator.

2. An electric jack type actuator constituting a unit of elongated cylindrical form and com-

- prising an elongated casing, an electric motor mounted at one end thereof and having an output shaft disposed lengthwise of the casing, reduction gearing in the casing and driven from the shaft, a screw jack disposed axially of the casing at the other end thereof which jack includes relatively rotatable and extensible male and female members whereof one is driven by the gearing to screw the other lengthwise thereof, means at said other end of the casing for guiding the said other jack member for linear movement axially of the casing, and means for restraining said other jack member from rotation in relation to the casing.
3. An actuator according to either of the preceding claims, wherein the gearing is epicyclic gearing.
4. An actuator as claimed in Claim 3, wherein the gearing consists of a plurality of individual readily-replaceable units, each comprising a gear carrier mounting a number of planet gears and a centrally-arranged sun wheel, the planet gears when the units are assembled together serving to transmit the drive from a pinion on the motor shaft to a final carrier secured to a worm shaft, the final carrier mounting planet gears which are adapted to mesh with the sun wheel on the next adjacent carrier, the planet gears of all the carriers meshing with an internally-toothed fixed annulus in the casing.
5. An actuator according to Claim 2, or Claim 2 as modified by Claim 3 or by Claims 3 and 4, having a bearing for the said one jack

member disposed at an end of the latter adjacent the gearing.

6. An actuator according to Claim 5, wherein the bearing serves the double function of a thrust-and-journal bearing.

7. An actuator according to any of the preceding claims, wherein the motor is of the permanent magnet type.

8. An electric jack-type actuator comprising a two-compartment casing, a permanent magnet electric motor located within one compartment and in driving connection with epicyclic type reduction gearing located within the other compartment, an extension on said casing beyond said other compartment, an axially-movable ram slidable within said extension, and a worm disposed co-axially of the motor in threaded engagement with corresponding threads in said ram and in driving connection with said epicyclic gearing, and means for preventing rotational movement of said ram within its associated extension.

9. An electric jack-type actuator substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 19th day of January, 1945.
MILES AIRCRAFT LIMITED and
ARTHUR STEWART HAWKINS.

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Chartered Patent Agents,
Nottingham, London.

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[This Drawing is a reproduction of the Original on a reduced scale.]

